UNIVERSITY OF CALIFORNIA
COLLEGE OF DENTISTRY

EXTENSION LECTURES

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HAND-CARVED PORCELAIN SHELL AND OTHER CROWNS, TOGETHER WITH AMALGAM MODEL TECHNIQUE FOR CROWNS AND INLAYS.

BY

Dr. GEO. L. BEAN

Professor of Dental Porcelain, College of Dentistry, University of California

JANUARY 3-7, 1916


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HISTORY

Porcelain shell or jacket crowns are by no means new. The literature of dentistry for the last twenty-five years devotes considerable space to their construction and use.

In the *Dental Cosmos*, Dr. Capon of Philadelphia and others have reported periodically their success with these crowns, and at no time have they receded from their favorable opinion of them.

The original work and development of this type of restoration was done by Doctor Land of Detroit, many years ago, and later modified by Doctor Land and Doctor Spaulding into what has become known as a porcelain shell. This is, essentially, a crown baked on a platinum-foil matrix, which foil is later removed and the crown cemented over a conical-shaped tooth stump. The work for many years was largely confined to peg-shaped lateral incisors, except in the hands of a few men, but since the search-light of the X-ray has been thrown upon our root fillings and the dental and medical professions have demonstrated systemic lesions that may arise from poorly treated and improperly filled roots, there has arisen throughout the country a demand for methods of operative procedure that will save vital pulps whenever possible.

It is probable that the reason the porcelain shell never came into popular use was that there are technical difficulties associated with its proper construction. The method about to be illustrated was developed with the idea of eliminating the uncertainties of handling porcelain in these delicate restorations, and so making it possible for the general practitioner of dentistry to handle this work as regular routine, rather than to send his patient to a specialist.

Where Indicated

(*a*) On a peg or rice-shaped laterals.

(*b*) Badly broken down or extensively decayed teeth with vital pulps, where any other type of porcelain crown would demand devitalization.

(*c*) Devitalized teeth where any uncertainty exists as to the healthy condition of the roots, which condition might later make the easy removal of the crown an advantage.

(*d*) Badly eroded or undeveloped teeth.

(*e*) Lower incisors, on account of their roots being small for dowels.

Summary of Advantages

(*a*) The saving of pulps, avoiding the uncertainty of root fillings in vital teeth requiring crowns.

(*b*) The avoidance of gingival or pericemental inflammation, as frequently found under banded crowns. Gold crowns on teeth prepared as for a porcelain shell cause less gingival irritation than when mounted in the usual way, but more than the porcelain.

(*c*) Appearance. No other artificial crown presents so natural an appearance.

(*d*) Strength; which is much greater than popularly supposed. The stress of mastication being directed against a larger surface than when the tooth crown has been cut away to the gingival, the root is more fully protected from fracture. The unmounted crown appears to be, and is, very fragile, but once mounted and supported at all points by the cement and stump it is very strong. For several successive years the same porcelain shell mounted on an extracted root was driven into a pine bench-top as an illustration to the students of the strength of these crowns when mounted.

(*e*) No danger of the root being split or perforated, as with dowel crowns.

(*f*) Limits the recurrence of caries because the cement line is almost eliminated and is also protected by healthy gingival tissue.

(*g*) Ease of removal if necessary, and ease of replacement if models are preserved, as they should be.

Comparative Disadvantages

None but those due to the operator's lack of technical skill and experience and the inability of some patients to pay for the time consumed.

Vitality of Pulp

No fear need be felt for the vitality of healthy pulps if certain precautions are carefully observed during the preparation of the stump and until the crown has been finally cemented. Excepting peg laterals and other undeveloped teeth, teeth requiring single crowns are usually badly broken down by caries on both mesial and distal and part of the occlusal surfaces. The resulting cavities have often been filled for some time previously so that the pulp has receded to a considerable extent. The remaining portion of the stump requires little more than the removal of the enamel on the lingual and labial sides, with no deep cutting such as would be necessary for the retention of fillings. The precautions to be taken are that at no time the tooth be overheated in grinding, especially when the work is done under an anesthetic, always using a stream of

water, and then that, before dismissing the patient, the stump be thoroughly sterilized, varnished, and covered with cement (not gutta percha) to which an antiseptic such as thymol has been added.

If the vital tooth is in a conspicuous position in the mouth a temporary crown made by hollowing out a detached post crown for the anterior teeth or the use of an old gold crown or even a copper band filled with cement for the posterior is indicated, as this serves to hold away the gum from the ledge lying under it and so facilitates the subsequent cementation as well as prevents irritation of the gums lying over the shoulder itself. Leaving teeth in this condition removes the chief occasion for haste in setting the final crown, and makes it possible to carry on more leisurely the necessarily involved laboratory technic.

Experience has shown that teeth that are quite sensitive before cementation of a porcelain shell soon become entirely comfortable even to applications of cold water, due to the very high insulating properties of the porcelain.

With bell-crowned bicuspids and molars, it is frequently unnecessary to extend the lingual shoulder further gingivally than to the greatest diameter of the tooth, and in many other cases not much more than the enamel is removed.

Operative Technic

The operative technic varies with the location of the tooth in the arch, the amount of tooth substance already lost, and the position of the adjoining teeth. Briefly, the object is to reduce the stump to a somewhat conical shape, with its base toward the gum; which base is surrounded by a shoulder or ledge about 0.5 mm. wide and located just under the free margin of the gum. Of course, where deep cavities exist these need only be cut out or filled with cement so as to present a uniform tapering surface, toward the incisal or occlusal, so that an impression of the stump may be withdrawn without distortion. The tapering of the sides is easily done with knife-edged stones, Hall's flexible disks, mounted cylindrical stones, chisels, and burs, but great care is necessary in the preparation of the shoulder. For this purpose square and fissure burs of small size, Miller's cylindrical stones, safe-sided end-cutting burs and Black's hatchets and chisels are all used. The ledge as well as the stump should be left with a surface as smooth and highly polished as practicable to facilitate the withdrawal of the impression. After shaping up the stump, but before cutting the ledge, a copper band approximately as long as the adjoining teeth, or at least longer than the stump, should be fitted fairly closely and shaped to firm contact with the proximate teeth, carefully festooning out for the curvature of the gum. One of the manu-

factured copper bands used for seamless crown work can usually be found suitable for this purpose.

After the stump is prepared, the copper band is filled with perfection modeling compound, thoroughly softened in hot water and pressed over the tooth. Two syringes, one with cold and one with hot water, should be ready. As the compound chills, a stream of warm water is thrown upon it, keeping it soft until it has pressed the gum away to take the impression of the root beyond the shoulder. The band may be removed for examination, but if this be done it is again warmed with hot water when replaced on the tooth and forced up a little farther than before.

Now, hold the compound firmly in position and chill with the cold-water syringe. Any excess of compound forced over the sides of the band either gingivally or incisally is now removed and the assistant directed to continue dropping cold water on the impression while a bridge

Fig. 1

impression tray is being filled with plaster mixed with *cold* water and an excess of salt. A plaster impression of the copper band in position and of the adjacent teeth is now taken and removed as soon as brittle, before the heat caused by the setting plaster has softened the modeling compound. The copper band will usually remain on the tooth. It is again chilled, then removed, and a wax bite is taken.

The next step is the selection of the proper colors of porcelain. When the adjoining teeth can be matched from a sample of one of the manufacturer's guides, this is all that is necessary, but when this cannot be done the color most nearly correct should be chosen and a memorandum made as to such changes as may be demanded. The temporary crown, before suggested, is now set with a temporary cement and the patient may be dismissed. I usually allow one hour for the operative technic just outlined.

It is an advantage in putting porcelain crowns on many molars, particularly uppers, where the roots diverge to a considerable extent, to be

able to insert the necessary dowels without running the risk of root perforations, or weakening them by attempting to make the canals parallel. This is easily avoided by setting dowels in the individual canals with cement, allowing them to extend to, and their ends to meet, well outside the pulp chamber as shown by the radiograph. See Figure 1. The pulp chamber is then slightly undercut and packed with amalgam, which is also carried up around the dowels to give them some conical or pyramidal form. From this point the procedure is as for a porcelain shell. Occasionally pulp chambers are so deep and the tooth so strong that little more, if any, attachment is needed than the amalgam alone.

At a subsequent sitting, after the amalgam has set, the impression is taken and the crown made as for a porcelain shell.

If it ever becomes necessary to remove a crown of this type it is easily done by cutting a groove in the porcelain with a knife-edge stone and splitting it. The amalgam can now readily be drilled out and the round tapering dowels, whose ends protrude from the pulp chamber, be removed separately with pliers.

Impressions for Other Types

The only variation from this method when taking an impression for dowel crowns is that, instead of filling the copper band with modeling compound *before* placing on the root, the band is first adjusted to the root and softer compound is packed firmly into it with pluggers until it has been forced into every irregularity and well into the root or pulp chamber. It is now chilled. A root plugger smaller than the root canal as enlarged for a dowel is heated in the flame and used as an explorer to find the canal openings prepared for one or more dowels. The previously fitted dowels are now warmed in the flame and pressed home through these openings. In going to their proper position, they will carry with them compound so that an accurate impression of the root canal is taken as well. After chilling, the plaster impression is taken as before. Upon the amalgam model made from this impression, any type of crown desired may be constructed, and made to fit more accurately than if the work were all performed in the mouth, as shown by the models. If through breakage of the porcelain, decay of the root, lack of contact, recession of the gum, change of color, or other causes, it becomes necessary to replace the porcelain of a dowel crown when the dowel is firmly anchored in the root, the root is prepared as desired without removal of the dowel, which should, however, be made slightly tapering by grinding, or by the addition of cement or amalgam. The impression is taken exactly as for a porcelain shell. The laboratory procedure will be shown later.

M. O. D. Cavities

To take an impression of an M. O. D. cavity in a bicuspid or molar, the copper band is fitted roughly and trimmed away so that it will not pass farther gingivally on the labial or lingual surface than the greatest diameter of the tooth. Care should be taken to see that the copper band presses close against the contact points of the proximate teeth. To take the impression, the band is placed in position and soft compound forced in with pluggers, while a stream of water is syringed onto the tooth, sufficiently hot to keep the compound soft and workable. A small piece of compound is added to take the occlusal surfaces of the adjoining teeth, the whole chilled and removed without taking a plaster impression. A small wax bite should be obtained.

As shown by the models, from this small and quickly obtained impression accurate models may be made that will show perfectly the cavity and tooth in amalgam, and the occlusal and contact points in plaster. The amalgam may be removed from or replaced in the plaster model at will, making the formation and withdrawal of a wax pattern a simple and accurate procedure. The gold casting may be forced into the model by placing it in the swaging device and swaging, and the inlay closely finished and polished while on the model, resulting in a much better fit than can possibly be obtained by working directly on the tooth.

A little experience will soon suggest ways of taking impressions of any cavity where a model would be an advantage, but one fact should be strongly emphasized, namely, that in order to get an accurate impression with modeling compound the material must be worked while thoroughly softened, and must be confined with some sort of matrix, such as a copper band, so that it cannot escape when packed in under heavy pressure. This cannot be accomplished through the use of small cavity impression trays.

Bridges

In the construction of bridges, a plaster impression of the copper band —modeling compound impressions of the abutments may be taken together and the models made therefrom so handled in the laboratory that no further impressions are necessary, the bridge being completed on the original models. Where inlay abutments are to be used there is far less danger of error in replacing the copper bands in the plaster impression than in replacing the inlays in a plaster impression taken while they are in the teeth. Another advantage of working on the amalgam models is that the assembled bridge may be removed for soldering and replaced on the models to be adjusted and finished. If any shrinkage or warpage has taken place, or the abutments are so far out of parallel that the bridge will not go to place, it is quite evident at this time and can be corrected or plans made for a proper change in the abutments.

Porcelain Inlays

Amalgam models are especially indicated in porcelain inlay work in labio-gingival cavities. The gum is easily forced away by the modeling compound and so a clear field of operation is obtained on the resulting model.

In complicated cavities where the burnishing of a matrix is a difficult operation, it may be greatly simplified by a combination of burnishing and swaging on an amalgam model. In fact, the rule holds good that the more difficult the operation of making an inlay or a crown in the mouth, the greater the necessity for a correct laboratory model; and after ten years' experience in developing and using this technic I can assure you that a little time spent in getting correct impressions is well repaid in the ease and certainty of subsequent procedures. For those having a laboratory assistant much time is saved, the laboratory steps becoming mere routine; and any competent office nurse can soon become quite proficient in the making of the amalgam and plaster models.

To Summarize

The important points to be observed in taking cavity or root impressions are:

1. When inlay or crown is to have contact with proximate teeth, the copper band must be firmly in contact with the contact points of these teeth.
2. The compound should always be soft for taking impressions and always chilled when being handled at other times.
3. All excess should be trimmed away so that overhanging particles will not stick to the plaster impression.
4. The compound must always be thoroughly confined by a matrix.

Laboratory Technique

This method was developed with the idea of having as much of the work as possible done in the laboratory, either personally or by an assistant. In the laboratory there is no fussy patient to annoy; no bleeding gums to bother; in fact, no gums at all, because they may be trimmed away from the plaster model or the amalgam model removed entirely; as much time as necessary may be used, at odd times if more convenient; and, as will be shown, it is possible to do everything that can be done in the mouth with greater ease, greater comfort and much more accuracy in the laboratory. If a failure results it is much easier to correct (unless it occur in the impression or model), making an extra visit of the patient unnecessary. The time used in obtaining the models is more than made up in the following procedures:

Construction of Models

The construction of the models is divided into the following steps, which should be followed out exactly as outlined for porcelain shell crowns. Variations for inlay and dowel crowns will be mentioned later.

1. Assemble and varnish plaster models.

2. Fill copper band with moldine form approximately as amalgam is wanted, which should be as shown by Figure 2.

3. Invest copper band containing moldine in plaster by setting moldine on glass slab or other smooth, flat surface and covering the whole with small mix of plaster.

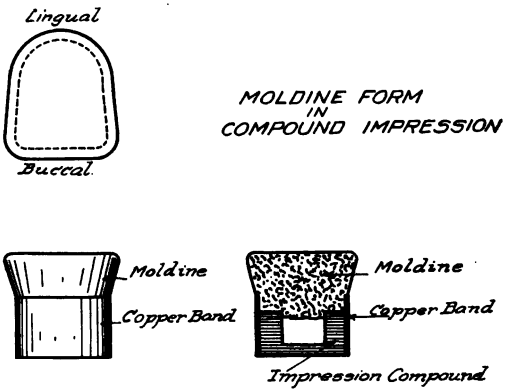


Fig. 2

4. When plaster has set, pick and wash out moldine and pack amalgam in its place. This step is not easy. The first application of amalgam should be quite soft and carefully rubbed into all parts of the impression in small pieces with smooth pluggers. As soon as the impression face is covered, drier amalgam is heavily packed with as large serrated pluggers as can be used, up to the level of the opening in the plaster, and set away to harden (Figure 3).

5. When the amalgam has set, cut away the plaster investment, using care not to disturb or mar the modeling compound, and trim the amalgam model so that the bottom is perfectly flat and smooth, so that the sides of the base have no undercuts and the base is wedge-shaped with its greatest width labially, and pyramidal with its base downward. The form just described should have been outlined by the moldine first placed in the copper band. The base should also be highly polished on all sides.

6. Place copper band now filled with amalgam in place in plaster impression.

7. Run plaster model and when set, separate impression, warm copper band and remove it together with the compound.

8. Adjust wax bite and model on articulator and varnish both model and the occluding teeth. We now have a "master model," that is, a perfect reproduction of the tooth to be crowned and the adjoining teeth.

9. Take plaster or modeling compound impression (plaster preferred) of the "master model" and also wax bite, with the amalgam model in place.

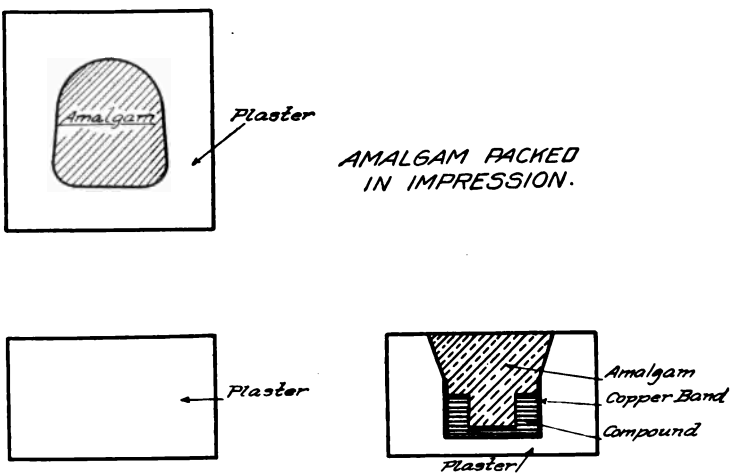


Fig. 3

10. Remove amalgam model by sliding out labially, the plaster having been cut away for this purpose, and place it in the plaster impression, varnish and make "working model" and bite. Mount on an articulator as before.

11. Remove the amalgam model as before and adapt by burnishing and swaging a platinum matrix of 1/1000 foil, carrying the foil half way down the sides of the pyramidal base.

12. Place the model, with the matrix in position, on a glass slab and cover with plaster.

13. When the plaster has set, remove the amalgam with sticky wax and fill the platinum matrix with alundum cement. Before packing the alundum cement, a small edge of the platinum foil is turned in from the

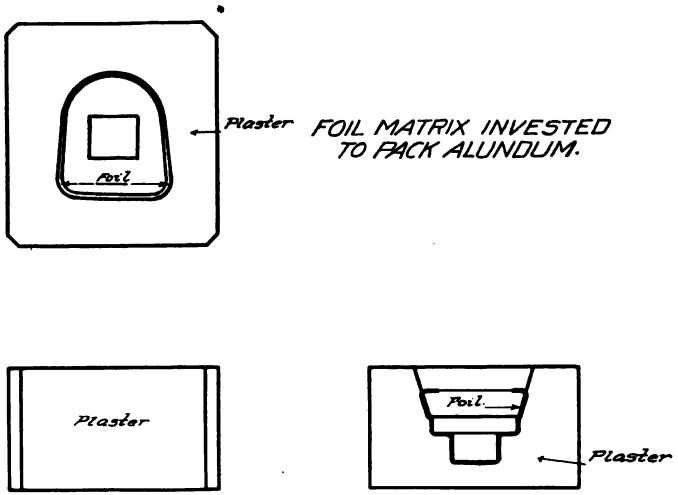
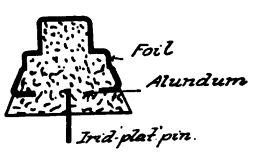


Fig. 4

plaster so that it will be firmly imbedded in the cement. Finally, insert a round iridio-platinum wire, about 17 gauge, in the center of the base, allowing it to protrude about one-eighth of an inch (Figure 4).

14. Dry immediately, if necessary, but slowly over a bunsen burner, finally bringing up to a red heat with the blowpipe. If there is no hurry, allow the cement to dry before applying heat. Then remove the plaster and bake the platinum-covered alundum model in an electric furnace at approximately 2600° F. We now have a foil-covered alundum model that has a wire firmly imbedded in it for ease of handling in the pin vise and furnace, and that will fit both the "master" and the "working"



FOIL COVERED ALUNDUM MODEL

Fig. 5

model, when a slot is made in the plaster to receive the wire (See Figure 5). The contacts of the proximate teeth on the working model are now cut away to allow for shrinkage of the porcelain, approximately one-fifth of the mesio-distal diameter of the finished crown. After each baking the alundum base and crown are tried on the "master model" for guidance as to the exact contact.

When the crown is finally baked, the iridio-platinum pin is removed from the base with pliers, and the alundum is removed by grinding out with small stones, under water. It can be dissolved out, or at least softened, by the addition of one drop of hydrofluoric acid left in the crown for five minutes, the outer surface being first covered with wax for protection.

The impression obtained of a root containing a dowel already set is handled in the laboratory exactly like a porcelain shell except that if the crown end of the dowel be round it is easier and will be stronger if its place in the impression be filled with a German silver wire of the proper size, allowing it to extend into the amalgam.

LABORATORY TECHNIQUE FOR DOWEL CROWNS WITH CAST METAL BASES

The first variation from the porcelain shell technic is in the application of the moldine to the root impression for the formation of a plaster matrix or form, into which the amalgam is packed to make the model.

In these cases, one or more dowels are present, necessitating a deeper model, and while the porcelain shell model was formed with a view to its exact duplication in alundum, this step is not required nor is but one plaster model, because it will not be necessary to trim or mutilate it, to allow for shrinkage of the porcelain body. Therefore, instead of making the amalgam model pyramidal with the base down, we make it pyramidal with the base up; in other words, tapering toward the root end. This model is removed from the impression occlusally by drilling a small hole through the plaster opposite the root end, and gently prying the model out (See Figure 6).

A few suggestions will be offered as to accurately adapting the cast base of a manufactured porcelain tooth of any suitable kind:

1. Grind the porcelain to shape, arranging for a shoulder at least as high as the contact points on the mesial, distal and lingual sides of the tooth if a bicuspid or molar. This will form a box in the casting to support the porcelain and provide an easy means to add to the contact points if necessary by the addition of a little solder.

2. Swage a matrix of 1/1000 platinum foil over the root, forming a band, if desired, and insert the dowel or dowels in their proper positions, fastening them with a little sticky wax.

3. Swage a similar foil matrix over the porcelain; place softened inlay wax on the root while on the model and set porcelain in proper position.

4. Remove the amalgam model and finish wax in desired form.

5. Remove waxed-up crown from the amalgam model—lift out porcelain and paint both exposed surfaces of platinum with a thin mixture of whiting in alcohol.

6. Invest and cast into a hot mold so that the gold will flow readily around the dowels.

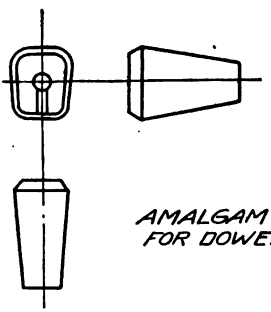


Fig. 6

Variations for other types of crowns suggest themselves, the fundamental steps for obtaining fit and adaptation being identical.

Laboratory Technic for M. O. D. Cast Inlays

The amalgam model base is first shaped as for the dowel crown. Plaster is now poured into the impression of the occlusal surfaces of the adjoining teeth and closely against the sides of the copper band, which you will remember was in close contact with the contact points of the proximate teeth. This establishes the mesio-distal diameter. After removing the band and compound the little wax bite is adjusted and poured. After separation we now have a model correctly showing contact and occlusion. Fill the cavity with inlay wax, carve, invest and cast the fillings.

It is unusual for one of these castings to go readily into place, in fact almost impossible without spreading the filling a trifle at the gingival. After removing any apparent roughness on the cavity side of the inlay, place it in the model, mount in the swaging device and drive to place

with unvulcanized rubber. After trying in the tooth and ascertaining if there is any deviation from the amalgam model, there being none, the inlay may be burnished, finished and polished on the model more advantageously than in the mouth, especially at the gingival margin.

Porcelain Technique Bodies

During the past few years so-called low fusing porcelains, meaning those porcelain bodies that will fuse in five minutes below the melting point of pure gold, have gradually been abandoned by many practitioners for so-called high fusing bodies that require a platinum rather than pure gold base upon which to fuse the material. More recently still the tendency is to raise the fusing point farther, so that while a short time ago a porcelain body fused at 2300° F. was considered high fusing, now bodies fusing in a few minutes around 2600° F. are in common use.

These higher fusing bodies are apparently stronger, shrink less in firing and are much more transparent and life-like in appearance. There is also less liability to over-fuse and great permanence of color is therefore to be expected. There are no unusual difficulties connected with their manipulation, excepting the strain on the electric furnace. Through changes in the construction of furnaces, such as the addition of larger resistors and the development of muffle and investing materials of greater purity, it is probable that the manufacturers will keep up with the procession and supply us with our needs in this direction. With our present furnace a great deal can be done to save the muffle winding by using a heavy insulated door, such as is supplied with the Hammond furnace, keeping the opening closed as much as possible when baking at high temperatures and allowing a little more time rather than great heat to do the baking. It is quite possible, but impracticable, to fuse so-called 2600° F. porcelain on pure gold if given enough time.

Foundation Bodies and Enamels

Crowns made under this method are finished in two or three bakes, and the natural shrinkage of the porcelain is perfectly controlled without the use of bodies of different fusing points, so that the use of an enamel body is eliminated except in cases where an addition is to be made after the platinum matrix has been removed.

Shrinkage and Density

Shrinkage and density are closely related, the former depending to a great degree upon the latter. Dense porcelain is to be obtained only by the observance of certain rules.

1. The body should be well spatulated to a thick creamy consistency and as much air as possible rubbed out.

2. It should be applied to the work in small amounts, each application being thoroughly condensed before more is added.

3. The work should be carried forward steadily, always remembering that dry body is not necessarily dense body and that the moisture dries out very rapidly in the air without the application of other means of absorption.

In carved crown work, burnishing or ironing the body into form is better practice than to attempt any extensive jarring to produce density. The alundum bases are quite absorbent. Therefore they should first be moistened with a drop of water before any body is applied, to prevent too rapid drying.

Obtaining Color

All crowns contain some proportion of yellowish hues, and most crowns can be made by the combination and blending of the proper hue of yellow with one other color. To obtain the selection, analyze the tooth taken from the guide by comparing its different sections with the color guide of the body to be used and make the proper choice. Now apply the yellow, building up the tooth approximately like the dentine and cover with the second body as an enamel, allowing them to overlap and blend at the right place. After the crown is built up in more or less block shape, it is carved to form and occlusion. Dry out and bake.

More particular details as to the handling of the porcelain will be gone into during the laboratory periods. Charts will also be displayed giving an analysis of certain color guides, but these are considered as being of little benefit to the operator who has an eye for color; and he who has not would better serve his patients by not attempting porcelain work.

Method of Using a Facing

This method is simple and appeals particularly to the inexperienced, but only in exceptionally favorable cases does it produce a crown of as fine appearance as the hand-carved. One of the chief factors adding to the lifelike appearance of the hand-carved porcelain shell is found in its very imperfections of form, whether caused intentionally or otherwise, and these imperfections are never found in manufactured teeth. Another disadvantage in the use of facings for a porcelain shell on vital teeth, where the labial plate is necessarily quite thin, is that the colors of a facing are blended by laying one color over another, so that in grinding out the facing to great thinness most of the underlying color is ground away and there is no opportunity for strengthening it by further additions.

If, however, a favorable case presents itself, the facing of any kind suitable is ground away on the back until it will permit of adjustment to the labial contour, particular care being taken to let it rest against

the stump and on the labial gingival ledge at some point, fastening it in position by cementing it to the base at the labial gingival with sticky wax. Now add the body to the lingual, making the first application thin and jarring down until the body has been thoroughly packed under the facing around the labial ledge and in all places inaccessible for burnishing. The building up and carving now goes forward as in a carved crown, using drier porcelain. Before insertion in the furnace most of the wax used to hold the facing in position temporarily is removed with a hot spatula. The rest will be readily burned away without injury to the porcelain, and the crown from here on is handled in the usual manner.

Alundum

Alundum is a refractory material made by fusing the mineral bauxite, a natural hydrate of alumina, or a pure aluminum oxide, in an electric furnace of the arc type. Until the invention of the process for the manufacture of alundum, bauxite was considered infusible. Most of the impurities found in bauxite are removed by certain processes of purification.

The manufacturers give it a melting point of 2050° centigrade (3722° F.) and that of bonded alundum, or alundum cement, as slightly below this. The thermal conductivity of bonded alundum is stated as being 2.1 times that of ordinary fire brick, and 1.6 times that of chemical porcelain; hence its great value in electric furnace muffles.

The alundum cement used in this work is alundum to which a ceramic binder has been added. A mass the size of a molar tooth shows no shrinkage or expansion. Porcelain may be baked directly on it without any injury to the porcelain whatsoever, but after fusing they are very difficult to separate.

The cement, which comes as a dry powder, is mixed with water to the consistency of thick mud. It is better, but not necessary, to allow it to dry before applying heat. It is not real cement because it does not set until considerable heat is applied, vitrification taking place at about 1000° C.

Alundum cement forms to be used in porcelain work should be previously baked to the fusing point of the porcelain so that any gases that might be formed at the higher temperature be first driven off.

The cement is valuable for investing the platinum matrix for a porcelain inlay, as it will thoroughly control shrinkage and preserve its form while applying and baking the porcelain, and for making small stands to support work while in the furnace. After repeated firings, but within certain limitations, it becomes harder.

Of the different grades manufactured by the Norton Company of Worcester, Massachusetts, the one known as R.A. 162 is the only one I have tested that answers all our requirements.